SURFACE PENETRATING RADAR SIMULATIONS FOR EUROPA. T.Markus, *NASA Goddard Space Flight Center, Code 975,Greenbelt, MD 20771, USA (Thorsten.Markus@nasa.gov)*, S.P. Gogineni, *University of Kansas, Lawrence, KS 66045*, J.L. Green, S.F. Fung, J.F. Cooper, W. W. L. Taylor, L. Garcia, *NASA Goddard Space Flight Center, Code 630, Greenbelt, MD 20771, USA*, B.W. Reinisch, P.Song, *University of Mass. Lowell, Lowell, MA 01854, USA*, R. F. Benson, *NASA Goddard Space Flight Center, Code 692, Greenbelt, MD 20771, USA*, D. Gallagher, *NASA Marshall Space Flight Center, Huntsville, AL 35812, USA.*

Of the icy moons of Jupiter, Europa is thought to be the best candidate for having a liquid ocean underneath a relatively small layer of ice. Estimates put the thickness of the ice shell anywhere between 2-30 km, with a few models predicting up to 100 km. Much of the uncertainties are due to the largely unknown temperature gradients and levels of water impurities across different surface layers. One of the most important geological processes is the possible transportation of heat by ice convection. If the ice is convecting, then an upper limit of about 20 km is set for the depth of the ocean underneath. Convection leads to a sharp increase in temperature followed by a thick region of nearly constant temperature. If ice is not convecting, then an exponentially increasing temperature profile is expected. The crust is thought to be a mixture of ice and rock. Although the exact percentage of rock is not known, it is expected to be low. Additionally, the ice crust could contain salt, similar to sea ice on Earth. The exact amount of salt and how that amount changes with depth is also unknown. In preparation for the Jupiter Icy Moons Orbiter (JIMO) mission, we performed simulations for a surface-penetrating radar investigating signatures for different possible surface and sub-surface structures of these moons in order to estimate the applicability of using radar with a frequency range between 1 and 50 MHz. This includes simulations of power requirements, attenuation losses, layer resolutions for scenarios with and without the presence of a liquid ocean underneath the ice, cases of convecting and non-convecting ice, different impurities within the ice, and different surface roughnesses.

The figure shows simulations of a received subsurface sounding signal at 10 MHz for a typical Europa scenario. In this case, we treated the 7-km ice as a layered medium consisting of a 2 km-thick icy crust with 5% impurities and 5 km-thick pure ice with bedrock or an ocean underneath. The 5-km layer of pure ice is assumed to be convecting or non-convecting with resulting differences in the temperature profile. The results show that we will be able to differentiate between a) ice covering bedrock from b) ice covering an ocean, as well as between convecting and non-convecting ice. The ice/rock-ice interface is at a depth of 2 km in both cases. The ice-ocean or ice-bedrock interface is at a depth of 7 km in both cases (the data beyond 7-km in are a) due to the foldover effect of the FFT).

The space environment above the icy surface of Europa is a source of radio noise in this frequency range from natural sources in the Jovian magnetosphere. The ionospheric and magnetospheric plasma environment of Europa affects propagation of transmitted and return signals between the spacecraft and the solid surface in a frequency-dependent manner. The ultimate resolution of the subsurface sounding measurements will be determined, in part, by a capability to mitigate these effects. We discuss an integrated multi-frequency approach to active radio sounding of the Europa ionospheric and local magnetospheric environments, based on operational experience from the Radio Plasma Imaging (RPI) experiment on the IMAGE spacecraft in Earth orbit, in support of the subsurface measurement objectives.